AMENDMENTS TO THE SPECIFICATION

Please amend the paragraph on page 1, line 5, to line 6, as follows:

The invention relates to the field of pistons for internal combustion engines, particularly for motor vehicles, heavy goods vehicles, agricultural machines, public works machines, and ships.

Please amend the paragraph on page 1, line 15, to line 22, as follows:

Pistons are usually produced in one piece from moulded or forged aluminium alloy. However, the increased stress conditions which have just been mentioned render the conventional pistons unsuitable. Consequently various solutions have been conceived to render the aluminium pistons compatible with the high-performance engines: insertion of alumina fibers ~~fibres~~ in the alloy to reinforce it, addition of steel inserts to reduce the expansion, deposition of graphite on the skirt to reduce friction, or machining of cooling channels to make the air or oil circulate there in such a way as to keep the piston at acceptable operating temperatures. However, all these solutions are expensive.

Please amend the paragraph on page 1, line 24, to page 2, line 3, as follows:

One conceivable solution might be the replacement of the aluminium alloy by a steel which, with comparable geometry, would have a better resistance to the mechanical and thermal stresses and to fatigue and a better temperature resistance. In fact, in the past steel has been used to manufacture pistons, but the use of steel for the manufacture of pistons for high-performance engines is not in fact conceivable first and foremost from the point of view of economics, because of the high density of this material. If it were desired to give the piston a sufficiently low mass in order to obtain high performance of the engine, it would be necessary to arrive at a very reduced wall thickness after forging of the piston. Such a thickness is inaccessible using conventional forging techniques if, for reasons of cost, it is desired to continue producing pistons in one piece.

Please amend the paragraph on page 2, line 5, to line 8, as follows:

The object of the invention is to render possible the manufacture, under economically advantageous conditions, of pistons for high-performance internal combustion engines, particularly making it possible for this purpose to use a steel, or another dense alloy with high mechanical properties, instead of a specially treated and/or shaped aluminium alloy.

Please amend the paragraph on page 2, line 11, to line 15, as follows:

To this end, the invention relates to a method of manufacture of a piston for an internal combustion engine~~,~~ in which the ~~said~~ piston is ~~being~~ formed from a metal part cast in one piece~~,~~ ~~wherein heating~~. Heating of a billet is carried out so as to bring it to an intermediate temperature between its solidus temperature and its liquidus temperature, and ~~that~~ shaping thereof by thixoforging is carried out.

Please amend the paragraph on page 2, line 17, to line 20, as follows:

The invention also relates to a piston for an internal combustion engine~~,~~ composed of a metal part cast in one piece, wherein it has been manufactured by heating of a billet so as to bring it to an intermediate temperature between its solidus temperature and its liquidus temperature, followed by shaping by thixoforging.

Please amend the paragraph on page 2, line 22, to line 25, as follows:

In one embodiment ~~the~~ lugs are formed by stirrup pieces provided on the base of the internal cavity of the piston, provided with a hole for the passage of a ~~the~~ pin joining the piston and the rod, and the piston has on its skirt openings which give access to the holes in the stirrup pieces.

Please amend the paragraph on page 3, line 3, to line 17, as follows:

Its composition may then be, in percentages by weight:

- $0.35\% \leq C \leq 1.2\%$
- $0.10\% \leq Mn \leq 2.0\%$

- $0.10\% \leq Si \leq 1.0\%$
- traces $\leq Cr \leq 4.5\%$
- traces $\leq Mo \leq 2.0\%$
- traces $\leq Ni \leq 4.5\%$
- traces $\leq V \leq 0.5\%$
- traces $\leq Cu \leq 3.5\%$
- traces $\leq Al \leq 0.060\%$
- traces $\leq Ca \leq 0.050\%$
- traces $\leq B \leq 100$ ppm
- traces $\leq Ti \leq 0.050\%$
- traces $\leq Nb \leq 0.050\%$,

the other elements being iron and conventional impurities resulting from the manufacture.

Please amend the paragraph on page 4, line 19, to page 5, line 5, as follows:

The success of an operation of thixoforging steel depends in the first instance upon the primary structure obtained at an intermediate temperature between the solidus and the liquidus during the cycle of heating the billet before it is shaped by thixoforging. Experience shows that before the shaping operation the billet must have a globular primary structure rather than a dendritic one. In this latter case, in the course of heating the segregation of the various alloy elements between the dendrites and the inter-dendritic spaces brings about a fusion of the metal preferentially in the inter-dendritic spaces enriched with alloy elements. The resulting liquid tends to be ejected at the start of the shaping operation, which results in an increase in the forces to be applied (which are being exerted on a metal more solid than was foreseen) and the appearance of defects within the part: segregations and problems of internal condition. When the shaping operation by thixoforging is carried out on a globular primary structure by suitable heating, a homogeneous product is obtained which can deform at high speed. The dendritic primary structure of the billet can be optimized ~~optimised~~ so as to obtain a homogeneous globular primary structure during heating before thixoforging. This can be obtained by acting in particular on the intensity of the electromagnetic

working during the solidification of the continuously cast product which makes it possible to fragment the dendrites, and on the intensity of cooling of this product which conditions the growth of the dendrites and the diffusion of the segregating elements, all for a given product size.

Please amend the paragraph on page 5, line 7, to line 12, as follows:

If the operation is carried out on a billet produced from a rolled bar derived from a continuous casting bloom or an ingot, this makes it possible to obtain globular structure in the course of heating prior to the thixoforging, without having to carry out a separate operation of globulization ~~globulisation~~ of the separated primary structure. In fact, the multiple reheating and substantial deformations undergone by the steel have then led to a very imbricate and diffuse structure where a primary structure is practically impossible to show.

Please amend the paragraph on page 5, line 20, to line 27, as follows:

The invention will be better understood upon reading the following description which is given with reference to the accompanying drawings, in which:

- Figure 1 shows in perspective and in longitudinal section an example of a piston according to the prior art, produced conventionally from forged aluminium alloy; and

- Figure 2 shows in the same way an example of a piston according to the invention, which can be substituted for the preceding one, produced from thixoforged carbon steel.

Please amend the paragraph on page 5, line 30, to page 6, line 16, as follows:

A ~~The~~ piston 1 according to the prior art, which is shown in section and in perspective in Figure 1, by way of reference, is designed to be used in a diesel engine of 1900 cc capacity with high-pressure direct injection. It is manufactured by forging of an aluminium alloy AS12UNG reinforced by alumina ~~fibres~~ fibers. Its external diameter is 80 mm. In a conventional manner its different parts consist of:

- an internal cavity 2, where the rod which will drive the piston 1 can be accommodated;
- a skirt 3 constituting the lateral wall of the piston 1, intended to come into contact with the cylinder liner, particularly by means of segments (not shown) disposed in ~~the~~ recesses 4, 5, 6 provided on the periphery of the skirt 3, at the level of a ~~the~~ top 7 of the piston 1;
- a surface 8 of the piston top constituting the part of the piston 1 facing the combustion chamber when the piston 1 is placed in the cylinder, and of which the shape, shown solely by way of example, is conventionally designed so as to favor ~~favour~~ the combustion of the fuel;
- a lug 9 having a hole 10 with walls reinforced towards the interior of the piston 1, provided in the skirt 3 so as to permit the passage through the hole 10 of the pin intended to join the piston 1 and the rod; a similar lug is disposed symmetrically opposite the lug 9 on the half of the piston 1 which is not shown.

Please amend the paragraph on page 6, line 18, to line 28, as follows:

It may be noted that:

- the skirt 3 has a relatively great thickness, of 6 mm;
- the top of the piston 7 is also thick, with a maximum distance between its surface 8 and a ~~the~~ base 11 of the internal cavity 2 of 29 mm,
- the distance between the top compression ring (the one which is placed in the recess 6 closest to the surface 8) and the surface 8 of the piston top 7 is 11 mm;
- the compression height, that is to say the distance between the center ~~centre~~ of the hole 10 of the lug 9 and the surface 8 of the piston top 7, is 51 mm;
- the diameter of the hole 10 of the lug 9 is 28 mm;
- the total height of the piston 1 is 68 mm;
- the weight of the piston is 525 g after machining.

Please amend the paragraph on page 9, line 27, to line 30, as follows:

The geometry of the piston 12 which has just been described is only an example of an embodiment of the invention, whether this be for the general appearance of the piston or for the

precise dimensions of its different parts. Thixoforging also ~~Also thixoforging~~ offers the possibility of providing reinforcing ribs of small thickness in different zones of the piston.

Please amend the paragraph on page 10, line 14, to line 20, as follows:

Optionally it is possible to add:

- deoxidizing ~~deoxidising~~ elements: Al (up to 0.060%) and/or Ca (up to 0.050%);
- elements improving the hardenability, such as B (up to 100 ppm);
- elements improving the machinability: S (up to 0.180%), Bi (up to (0.080%), Te (up to 0.020%), Se (up to 0.040%), Pb (up to 0.070%);
- elements blocking the enlargement of the grain such as Ti (up to 0.050%) and Nb (up to 0.050%).

Please amend the paragraph on page 12, line 6, to line 16, as follows:

For applications which are particularly demanding especially in terms of the temperatures reached at the piston head, it is conceivable to use steels which permit hot working such as hot-tooling steels 38CRMoV5, 45CrMoV6, 55NICrMoV7, conventional high-speed steels or high-carbon steels, and also cast irons or alloys based on iron-nickel or cobalt-nickel. The use of stainless steels may also be envisaged for cases where the piston would be required to work in contact with fuels containing particularly corrosive additives, for example martensitic stainless steels Z40Cr13 to Z200Cr13. All these materials, as well as the carbon steels of the type which can be used in the invention, have the characteristic of a carbon content which is high (0.35% at least) or even very high. This is an element very favourable to the thixoforging operation because it lowers the solidus temperature and widens the solidification range; thus ~~Thus~~ this gives easier access to the optimum range of liquid fraction in the metal.

Please amend the paragraph on page 12, line 18, to line 20, as follows:

It will be seen that the invention can be applied to a large variety of alloys, the essential feature being that their mechanical and thermal characteristics are very suitable for ~~their~~ use in ~~for~~ forming pistons, and that they are well adapted to thixoforging.